Did the Preflood Earth Have a 30-Day Lunar Month?

Robert B. Brown, PhD
Department of Astronautics
United States Air Force Academy
Colorado, USA

> *Then God said, "Let there be lights in the expanse of the heavens to separate the day from the night, and let them be for signs, and for seasons, and for days and years and let them be for lights in the expanse of the heavens to give light on the earth"; and it was so. And God made the two great lights, the greater light* [the Sun] *to govern the day, and the lesser light* [the Moon] *to govern the night;* **[*Genesis 1:14–16a*]**

> *And God saw all that He had made, and behold it was very good.* **[*Genesis 1:31*]**

Today we have a 29.53-day lunar month.[1] However, many ancient writings indicate that at one time there was a 30-day lunar month. Genesis 7:11, 7:24, and 8:3-4 tell us that exactly 5 months elapsed during the first 150 days of the flood. This suggests that the preflood Earth may have had exactly 30 days in every month.

Even after the flood, many early calendars still used a 30-day month. Ancient Egyptian astronomers divided the year into three seasons, each with four 30-day months. Then to achieve the known 365-day year, five days were added at the end of the year.[2] The Falsi calendar in Asia Minor and India was similar.[3] Also similar were the early Greek and Syrian calendars, as well as the calendar established in the 4th century B.C. by Seleucus Necator, one of Alexander the Great's generals. All of these calendars consisted of 12 months, each with exactly 30 days. Then five days were added to the end of the year to account for the 365-day year, and in some cases a sixth day was added every four years to account for leap year.[4]

Later, Mesopotamia adopted a calendar with 29-day months, which were called "hallow months" as well as 30-day months, called "full months."[5] The Greeks used a similar calendar and also called the 30-day months "full months" and the 29-day months "hallow months."[6] Perhaps, 30-day months were called "full" and shorter months were "hallow," because they believed at one time all months were 30 days in length.

References in the Vedic and classical Sanskrit texts give an explanation why the length of a year and a month changed. These manuscripts point to a "cosmic upheaval in [the] remote past." They explain that we used to have a 360-day year, but the Earth "underwent a total upheaval," and as a result "the Earth's period of revolution round the Sun in 360 days was changed to 365 days." This also caused the Moon to undergo a "serious perturbation," and "the period of lunation was very probably changed."[7]

Why did so many early cultures prefer a 30-day lunar month, and why do some Vedic and Sanskrit texts refer to drastic changes that altered the length of a year and the lunar month? Perhaps they heard stories passed down from Noah or one of his descendants. Noah lived 448 years after the flood, and his son Shem lived 500 years after the flood. [See Figure 232 on page 494.] I imagine all eight of the people on the Ark lived a long time and told everyone they knew about the events of the flood and what life was like before the flood. They also probably helped establish calendars after the flood. If there was a 30-day month before the flood, it is very likely that this was initially the length of a month used after the flood.

There is also evidence that rocky debris from the Earth impacted the Moon recently, which could have caused the "serious perturbation" that early Vedic and Sanskrit texts claimed altered "the period of lunation."[7] The Apollo 17 astronauts discovered that the Moon has an extremely thin atmosphere, about 10^{-14} that of Earth. These gases come from several sources, but the relatively large amount of oxygen probably comes from dissociated water vapor that collided with the Moon. Today's lunar atmosphere may be a remnant of water from the flood. Ice recently discovered on the moon falsifies theories on the Moon's evolution, but is consistent with the hydroplate theory. The Moon is also much warmer than expected. [See **"Hot Moon**," Endnote 84 on page 103 and Endnote 69 on page 328.] This extra heat is likely due to the recent impacts right after the flood. Finally, the tight clustering of lunar craters and the fact they are located on the side of the Moon facing the Earth indicates that the craters were formed from impacts during a short period of time from asteroids coming from the same direction. Furthermore, these asteroids likely hit the side of the Moon that was facing the Earth at the time. [See the caption for Figure 171 and Item 12 on page 317.] All of this physical evidence points to the strong possibility that the Moon was struck from debris that was recently launched from the Earth.

Could these impacts have altered the Moon's orbit, changing it from a 30-day lunar cycle to the 29.53-day lunar month we have today? Could this also explain why the Moon's orbit is slightly elliptical now? As discussed on page 352, it is estimated that the Earth lost about 3% of its mass when the fountains of the great deep erupted. How much of this debris would have had to impact the Moon to change its orbit to what we see today?

These questions are answered in the following calculations that show if only 1.22% of the debris launched from the Earth hit the Moon, the lunar month would have changed from exactly 30 days before the flood to the 29.53-day lunar month we have today. This would also

have changed the Moon's orbit from a circle to the slightly elliptical shape we see today (eccentricity of 0.0549).[1] Other key parameters for the Moon would also match what we see today. [See Table 1 on page 7.]

Orbit of the Moon before the Flood

This analysis begins by specifying the initial conditions for the Earth and the Moon before the flood. It is assumed that the Earth lost about 3% of its mass during the flood, and 1.22% of this mass impacted the Moon, increasing the Moon's mass. Therefore, the flood slightly altered the mass of the Earth and Moon. The gravitational parameter, μ, is equal to the gravitational constant, G, times the mass of an object. Subscripts are used to indicate if the parameters are for the Earth (E) or Moon (M). Subscripts also designate whether a quantity is before the flood (BF) or after the flood (AF).

$$\mu_{EBF} = GM_{EBF} = 410{,}928.29\,\frac{km^3}{sec^2}$$
$$\mu_{MBF} = GM_{MBF} = 4{,}752.39\,\frac{km^3}{sec^2} \qquad (1)$$

For small masses, like man-made satellites that orbit the Earth, it is common to ignore the mass of the satellite when calculating orbital parameters because their mass is so much smaller than the mass they orbit. However, for large bodies, like the Moon, calculations need to account for the mass of the orbiting body. Therefore, the combined gravitational parameter of the Earth and Moon will be used for the analysis here.

$$\mu_{(E+M)BF} = G(M_{EBF} + M_{MBF}) = 415{,}680.68\,\frac{km^3}{sec^2} \qquad (2)$$

It is also assumed that the Moon's orbit was a perfect circle before the flood, so its eccentricity was zero, and it had a semimajor axis of 395,884 km.

$$e_{MBF} = 0.00 \qquad a_{MBF} = 395{,}884\,km \qquad (3)$$

Finally, there were also 360 days in a year before the flood, not the 365.242 days we have today. [See Endnote 34 on page 181.]

Given these initial conditions, the velocity of the Moon's circular orbit and its period before the flood were,

$$V_{MBF} = \sqrt{\frac{\mu_{(E+M)BF}}{a_{MBF}}} = \sqrt{\frac{415{,}680.68}{395{,}884}} = 1.0247\,\frac{km}{sec} \qquad (4)$$

$$P_{MBF} = 2\pi\sqrt{\frac{a^3{}_{MBF}}{\mu_{(E+M)BF}}} = 2\pi\sqrt{\frac{(395{,}884)^3}{415{,}680.68}} = 2{,}427{,}449\,sec \qquad (5)$$

To convert this period into days, this number must be divided by 86,400, which is the number of seconds in one day. Also, to account for the shorter length of a day before the flood, it also needs to be multiplied by the ratio of 360/365.242.

$$P_{MBF} = 2{,}427{,}449\,sec\left(\frac{1\,day_{AF}}{86{,}400\,sec}\right)\left(\frac{360\,days_{BF}}{365.242\,days_{AF}}\right)$$
$$= 27.692\,days_{BF} \qquad (6)$$

This is called the sidereal period. It is the time required for the Moon to travel 360° around the Earth and arrive at the same point relative to the stars. However, because the Earth moves relative to the Sun, the Moon has to revolve more than 360° around the Earth between successive full Moons (the definition of a synodic period, or lunar month). If there were exactly 12 lunar cycles in a year before the flood, the Earth would have moved 30° each month around the Sun$\left(\frac{360}{12}\right)$. As a result, the Moon would have had to revolve an extra 30° around the Earth for each lunar cycle. This is illustrated in Figure 1.

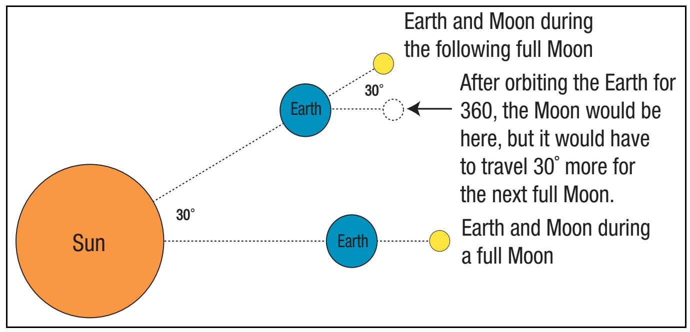

Figure 1: The synodic period required the Moon to revolve around the Earth 30° more than one complete revolution before the flood—or 390° total.

Therefore, before the flood, the Moon would have had to revolve 390° around the Earth to make one complete lunar cycle, and the synodic period to have been

$$SP_{MBF} = 27.692\,days_{BF}\left(\frac{390}{360}\right) = 30.000\,days_{BF} \qquad (7)$$

which is what people on the Earth would have used to determine the length of a month before the flood.

The Debris as It was Launched from the Earth

At the time of the flood, approximately 3% of the Earth's mass was launched into space. Some of that mass would have had enough velocity to escape the Earth's sphere of influence and become comets and asteroids. A very small percentage of this debris (1.22%) hit the Moon. For this analysis it is assumed this mass was launched vertically from the surface of the Earth by the fountains of the great deep, with a velocity of 11.35 km/sec (equal to 7.05 miles/sec).

In addition to this vertical velocity, the debris would also have had an eastward velocity due to the Earth's rotation.

The Earth rotates today 0.4651 km/sec at the equator. Before the flood it would have been rotating slower, resulting in 360 days in a year instead of 365.242 days.

Equatorial Velocity before the flood =

$$0.4651\left(\frac{360}{365.242}\right) = 0.4584\,\frac{\text{km}}{\text{sec}} \tag{8}$$

This mass would not necessarily have been launched near the equator though. Debris would have been launched from latitudes corresponding to those of today's Mid-Oceanic Ridge. Because the angle between Moon's orbit and the equatorial plane is 18.28° - 28.58°, the debris that hit the Moon could have come from a range of latitudes.[1] If the debris came from 28.58°, its eastward velocity would have been

Velocity at 28.58° Latitude =

$$0.4584\cos(28.58^\circ) = 0.4025\,\frac{\text{km}}{\text{sec}} \tag{9}$$

There is no way to know if the debris was launched with a maximum eastward velocity of 0.4584 km/sec, a minimum velocity of 0.4025 km/sec, or some intermediate value. For now, these calculations will assume the maximum velocity of 0.4584 km/sec. Later it will be shown that even if the minimum velocity was used, the final numbers would not change much.

If the debris that impacted the Moon left the Earth from the equator with an eastward velocity of 0.4584 km/sec and a vertical velocity of 11.35 km/sec, it would have had an equatorial orbit. Also, using the Pythagorean Theorem, the magnitude of the debris' velocity would have been 11.35925 km/sec. This is consistent with the estimated average velocity of approximately 11.2 km/sec for trans-Neptunian objects (TNOs) and irregular Moons in Table 39, on page 573.

Using this velocity magnitude, along with the gravitational parameter of the Earth before the flood (μ_{EBF}), the specific mechanical energy of the debris was calculated. Here the subscript "D" is used to denote the debris' orbit. It is assumed that the Earth's radius was the same before the flood as it is now, 6378.137 km, and the mass lost at the time of the flood still affected the departing debris. This is why the calculations below use the gravitational parameter before the flood, not after the flood.

$$\varepsilon_D = \frac{V_D^2}{2} - \frac{\mu_{EBF}}{R_D} = \frac{(11.35925)^2}{2} - \frac{410{,}928.29}{6378.137} = 0.08869\,\frac{\text{km}}{\text{sec}} \tag{10}$$

This slightly positive specific mechanical energy indicates the orbit was barely hyperbolic relative to Earth, meaning the debris had just enough energy to escape the Earth's gravitational field (based on the standard definition that potential energy is zero an infinite distance from Earth).

This allowed the semimajor axis of the debris' orbit to be found.

$$a_D = \frac{\mu_{EBF}}{2\varepsilon_D} = \frac{-410{,}928.29}{2(0.08869)} = -2{,}316{,}644\,\text{km} \tag{11}$$

As expected for a hyperbolic orbit, the semimajor axis is negative.

In order to calculate the debris' eccentricity, the specific angular momentum had to be found. This is simply the distance the debris is from the center of the Earth times the velocity in the horizontal direction, which in this case is in the eastwardly direction found in Equation 8.

$$h_D = R \times V_{horizontal} = 6{,}378.137(0.4584) = 2{,}923.9\,\frac{\text{km}^2}{\text{sec}} \tag{12}$$

This parameter, *p*, for the debris' orbit was then found.

$$p_D = \frac{h_D^2}{\mu_{EBF}} = \frac{(2{,}923.9)^2}{410{,}928.29} = 20.804\,\text{km} \tag{13}$$

The parameter of an orbit is also equal to $a(1 - e^2)$, which allows the eccentricity to be found.

$$e_D = \sqrt{1 - \frac{p_D}{a_D}} = \sqrt{1 - \frac{20.804}{-2{,}316{,}664}} = 1.000004 \tag{14}$$

As previously mentioned, this is just barely a hyperbolic orbit, so the eccentricity should be just slightly greater than one.

The Debris when it arrived at the Moon

It is assumed the debris' orbit can be treated as a two-body problem as it travelled to the Moon, meaning the debris was only affected by the Earth's gravity until it reached the Moon's sphere of influence. Therefore, the specific energy and eccentricity did not change.

Using the value for ε_D, found in Equation 10, the velocity of the debris was calculated when it arrived at the Moon's distance from the Earth (395,884 km from Equation 3). Notice, Equation **15** is the same as Equation 10; it is just rewritten here to solve for velocity now that energy is known. Also, the subscript "DM" denotes the debris' position, *R*, and velocity, *V*, when it arrived at the Moon. This

$$V_{DM} = \sqrt{2\left(\varepsilon_D + \frac{\mu_{EBF}}{R_{DM}}\right)} = \sqrt{2\left(0.08869 + \frac{410{,}928.29}{395{,}884}\right)} 1.5011\,\frac{\text{km}}{\text{sec}} \tag{15}$$

is the magnitude of the velocity vector, but the components of the velocity vector are needed to determine how the debris affected the Moon's orbit. To find these components, true anomaly and the flight path angle had to be calculated first.

True anomaly, ν, is the angle from perigee to the position vector. This was found using the solution to the two-body equation of motion given in Equation 16.

$$R = \frac{p}{1 + e\cos(\nu)} \qquad (16)$$

Rewriting this to solve for true anomaly,

$$\nu_{DM} = \cos^{-1}\left(\frac{\frac{p_D}{R_{DM}} - 1}{e_D}\right) = \cos^{-1}\left(\frac{\frac{20.804}{395.884} - 1}{1.000004}\right) = 179.388° \qquad (17)$$

It is now easy to estimate the time it would take for the debris to travel to the Moon. The debris was in a slightly hyperbolic orbit (*e* = 1.000004), and it arrived at the Moon's sphere of influence with υ =179.388°. The travel time can be accurately estimated as the time required to travel from perigee to apogee (for an elliptical orbit (*e* slightly less than 1.0). This elliptical orbit would have a semimajor axis that was half the distance between the Earth and Moon before the flood, or 197,942 km. Using these values, it would take five days for the debris to reach the Moon's sphere of influence, and very shortly after that it would impact the Moon.

$$Time = \pi\sqrt{\frac{a_{MBF}^3}{\mu_{(E+M)BF}}} = \pi\sqrt{\frac{(197{,}942)^3}{415{,}680.68}}$$
$$= 429{,}118 \text{ sec} = 5.0 \text{ days} \qquad (18)$$

The flight path angle, γ, when the debris arrived at the Moon's sphere of influence was found next. This is the angle of the velocity vector above the local horizon as shown in Figure 2. The horizontal component of the velocity vector is $R\dot{\nu}$, and the vertical, or radial, component of the velocity vector is $\dot{R}$.

$\dot{R}$ can be found by taking the derivative of the solution to the two-body equation of motion, given in Equation 16. Only true anomaly, *ν*, changes. The parameter, *p*, and eccentricity, *e*, would not change. Therefore,

$$\dot{R} = \frac{p\dot{\nu}\, e\sin(\nu)}{[1+e\cos(\nu)]^2} \qquad (19)$$

Referencing Figure 2, the flight path angle can be calculated using Equations 16 and 19.

$$\gamma = \tan^{-1}\left(\frac{\dot{R}}{R\dot{\nu}}\right) = \tan^{-1}\left[\frac{\frac{p\dot{\nu}\, e\sin(\nu)}{[1+e\cos(\nu)]^2}}{\frac{p}{1+e\cos(\nu)}\dot{\nu}}\right]$$
$$= \tan^{-1}\left(\frac{e\sin(\nu)}{1+e\cos(\nu)}\right) \qquad (20)$$

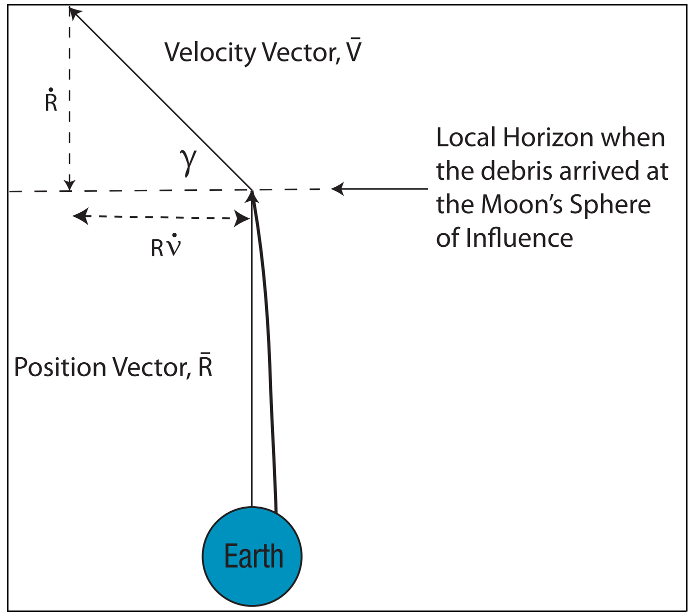

Figure 2: Flight Path Angle, γ of the Debris when it arrived at the Moon. The Figure is drawn looking down at the North Pole.

This equation allows the flight path angle to be calculated for the debris when it arrived at the Moon. As found in Equation 14, the eccentricity of the debris' orbit was barely greater than 1.0, and from Equation 17, the true anomaly of the debris when it reached the Moon's distance from the Earth was 179.388°. Therefore,

$$\gamma_{DM} = \tan^{-1}\left[\frac{e_D\sin(\nu_{DM})}{1+e_D\cos(\nu_{DM})}\right] = \tan^{-1}\left(\frac{1.000004\sin(179.388°)}{1+1.000004\cos(179.388°)}\right) = 89.718° \qquad (21)$$

Using this value and the magnitude of the velocity vector, found in Equation 15, the two components of the debris' velocity were found when it was 395,884 km from the Earth (the distance between the Earth and Moon before the flood). Because these calculations assumed the debris was in an equatorial orbit, the horizontal direction was eastward, and there would have been no component of the velocity vector in the northern or southern direction.

$$V_D \text{ in Radial Direction} = V\sin(\gamma) = 1.5011\sin(89.718°) = 1.5011\frac{km}{sec}$$
$$V_D \text{ in Easterly Direction} = V\cos(\gamma) = 1.5011\cos(89.718°) = 0.007386\frac{km}{sec} \qquad (22)$$

Changes in the Moon's Orbit

The Moon was also orbiting the Earth at this same distance (395,884 km) with a velocity of 1.0247 km/sec, found in Equation 4. The Moon was assumed to be in a circular orbit, so there was no radial velocity. However, the Moon did not just move eastward. Because the Moon is inclined relative to the Earth's equator between 18.28° and 28.58°, its orbit is tipped on average 23.43° relative to the equator (or out of the page if the Moon were shown in

Figure 2).[1] Therefore, the Moon would have been moving eastward with a velocity of 0.9402 km/sec on average.

$$V_{\text{MBF Eastward}} = 1.0247 \cos(23.43°) = 0.9402 \frac{\text{km}}{\text{sec}} \qquad (23)$$

Due to its inclination, the Moon would also have had an average velocity component in the northern or southern direction equal to 1.0247 sin (23.43°) = 0.4075 km/sec as it crossed the equator.

Comparing Equations 22 and 23, notice the Moon would have been moving much faster eastwardly than the debris (0.9402 > 0.007386). This means the Moon would have run into the debris, similar to what would happen if a few boulders were softly tossed in front of a fast moving car. These extremely large rocks reduced the Moon's energy, which would have dropped the Moon into a lower orbit and decreased its period. It is relatively easy to calculate exactly how the Moon's velocity would have been changed by the debris. Once the debris entered the Moon's Sphere of Influence (SOI), it is fair to assume that only the Moon affected the debris' orbit. Also, because gravity is a conservative force, it is not necessary to determine the exact orbit of the debris inside the Moon's SOI. All that is needed is to compare the total momentum of the debris and Moon immediately before the debris entered the Moon's SOI and set this equal to the momentum of the Moon after impact.

Instead of using momentum as the product of mass and velocity (mV), these calculations use μV, which is more convenient and slightly more accurate. (Remember μ is the gravitational constant, *G*, times the mass of a body.) The following calculations also use the assumptions listed previously that 3% of the Earth's mass was lost at the time of the flood, and 1.22% of this mass impacted the Moon. Therefore,

$$\mu_D = 1.22\%(3\%)(410{,}928.29) = 150.4 \frac{km^3}{sec^2} \qquad (24)$$

Also, using μ from Equation 1, the gravitational parameter of the Moon after impact would be

$$\mu_{MAF} = 4{,}752.4 + 150.4 = 4902.8 \frac{km^3}{sec^2} \qquad (25)$$

Using these values for μ, the velocity of the Moon after the flood was found in Equation 25 to be 0.04605 km/sec in the radial direction.

$$\mu_{MBF} V_{\text{M Radially}} + \mu_D V_{\text{D Radially}} = (\mu_{MAF}) V_{\text{M Radially After Flood}}$$

$$4{,}752.4(0) + 150.4\ (1.5011) = (4902.8) V_{\text{M Radially After Flood}} \qquad (26)$$

$$V_{\text{M Radially After Flood}} = 0.04605 \frac{\text{km}^3}{\text{sec}^2}$$

In the eastern direction the Moon would have been moving 0.91156 km/sec after impact.

$$\mu_{MBF} V_{\text{M Eastward}} + \mu_D V_{\text{D Eastward}} = \mu_{MAF} V_{\text{M Eastward Eastward After Flood}}$$

$$4{,}752.4\ (0.9402) + 150.4\ (0.007386) = (4902.8)\ V_{\text{M Eastward Eastward After Flood}} \qquad (27)$$

$$V_{\text{M Eastward Eastward After Flood}} = 0.91156 \frac{km}{sec}$$

The Moon would have also been moving in the northern (or southern) direction 0.39503 km/sec after impact.

$$\mu_{MBF} V_{\text{M Northward}} + \mu_D V_{\text{D Northward}} = \mu_{MAF} V_{\text{M Northward After Flood}}$$

$$4{,}752.4\ (0.4075) + 150.4(0) = (4902.8\ V_{\text{M Northward After Flood}} \qquad (28)$$

$$V_{\text{M Northward After Flood}} = 0.39503 \frac{km}{sec}$$

Using the Pythagorean Theorem, the magnitude of the Moon's velocity after impact was calculated from these three components to be 0.99454 km/sec.

To summarize, three things changed for the Earth and Moon at the time of the flood that affected the Moon's orbit:

1. The Earth lost 3% of its mass, so

$$\mu_{EAF} = 97\%(410{,}928.29) = 398{,}600.4 \frac{km^3}{sec^2} \qquad (29)$$

2. The Moon's mass changed very slightly when 1.22% of the mass ejected from the Earth hit the Moon. As calculated in Equation 25, μ_{MAF} = 4902.8 km/sec.
3. The Moon's velocity changed as found in Equations 26 through 28.

As mentioned previously, when calculating the orbit for large objects like the Moon, the gravitational parameters of the two bodies need to be combined. Therefore,

$$\mu_{(E+M)AF} = \mu_{(E\,AF} + \mu_{(M\,AF} = 398{,}600.4 + 4902.8 + 403{,}503.2 \frac{km^3}{sec^2} \qquad (30)$$

The steps to calculate the semimajor axis and eccentricity of the Moon after the flood follow the exact same process outlined in Equations 10 through 14. First, knowing the new velocity of the Moon, and assuming its position did not change immediately (R = 395,884 km from Equation 3), the Moon's specific mechanical energy after the flood would be

$$\varepsilon_{MAF} = \frac{V_{MAF}^2}{2} - \frac{\mu_{(E+M)AF}}{R_{MAF}} = \frac{(0.99454)^2}{2} - \frac{403{,}503.2}{395{,}884} = -0.52469 \frac{km^3}{sec^2} \qquad (31)$$

This allows the semimajor axis of the Moon after the flood to be found.

$$a_{MAF} = \frac{-\mu_{(E+M)AF}}{2\varepsilon_{MAF}} = \frac{-403{,}503.2}{2(-0.52439)} = 384{,}514\,km \qquad (32)$$

The specific angular momentum of the Moon after the flood is simply the distance the debris is from the center of the Earth times the velocity in the horizontal direction.

In this case, the horizontal velocity of the Moon had an eastwardly and northerly (or southerly) component found in Equations 27 and 28. Using the Pythagorean Theorem, the total horizontal velocity was found.

$$h_{\text{MAF}} = R_{\text{MAF}} \times V_{\text{horizontal}} =$$

$$395{,}884\sqrt{(0.91156)^2 + (0.39503)^2} = 393{,}300\ \frac{km^3}{sec} \quad (33)$$

The parameter, p, for the Moon's orbit after the flood was then found.

$$p_{\text{MAF}} = \frac{h_{\text{MAF}}{}^2}{\mu_{(\text{E+M})}\text{AF}} = \frac{(393{,}300)^2}{403{,}503.2} = 383{,}354\ km \quad (34)$$

Because $p = a\,(1 - e^2)$, the eccentricity of the Moon's orbit after the flood was

$$e_{\text{MAF}} = \sqrt{1 - \frac{p_{\text{MAF}}}{a_{\text{MAF}}}} = \sqrt{1 - \frac{383{,}354}{384{,}514}} = 0.05492 \quad (35)$$

From these values the Moon's radius of perigee, R_P and radius of apogee, R_A, after the flood were calculated.

$$R_{\text{p MAF}} = a_{\text{MAF}}(1 - e_{\text{MAF}}) = 384{,}514(1 - 0.05492) = 363{,}396\ km$$
$$R_{\text{A MAF}} = a_{\text{MAF}}(1 + e_{\text{MAF}}) = 384{,}514(1 + 0.05492) = 405{,}632\ km \quad (36)$$

Also, the Moon's sidereal period was found.

$$P_{\text{MAF}} = 2\pi\sqrt{\frac{a^3_{\text{MAF}}}{\mu_{(\text{E+M})\text{AF}}}} = 2\pi\sqrt{\frac{(384{,}514)^3}{403{,}503.2}}$$
$$= 2{,}358{,}438\ sec = 27.297\ days_{AF} \quad (37)$$

As explained previously, this is the time for the Moon to travel 360° around the Earth. However, the Moon must travel slightly farther in between successive full Moons. Prior to the flood, the Moon had to move an extra 30° for each lunar cycle. [See Figure 1.] Because the length of a month today is 29.53 days, and the length of a year is 365.242 days, the Moon must now move an extra $\left(\frac{29.53}{365.242}\right)360^\circ = 29.106^\circ$ today. Therefore, the Moon's synodic period after the flood should be

$$SP_{\text{MAF}} = 27.297\ days_{\text{AF}}\left(\frac{360 + 29.106}{360}\right) = 29.504\ days_{\text{AF}} \quad (38)$$

It is actually 29.53 days, which means these calculations are only off by only 0.026 days or 37 minutes, with a percent error of only 0.09%. Six other parameters describing the Moon's orbit around the Earth are even closer to the actual values. All seven of these numbers are all summarized in Table 1.

Validity of Assumptions

Now that the calculations are complete, before making any conclusions, it is appropriate to look at the validity of the assumptions made, and see how sensitive the final answers were to the four most significant assumptions made. Those assumptions were:

1. The debris that hit the Moon was launched from the Earth at the equator.
2. The debris left the Earth with a vertical velocity of 11.35 km/sec.
3. The Earth lost 3% of its mass during the flood.
4. 1.22% of the mass ejected from the Earth hit the Moon.

Let's first look at the assumption made in Equation 8, when it was assumed the debris that hit the Moon came from the equator and had an eastward velocity of 0.4584 km/sec. The debris could have could have come as far north (or south) as 28.58° latitude. If the calculations above were repeated assuming the debris was launched from the maximum latitude of 28.58° as shown in Equation 9, the debris would have the slowest possible eastward velocity of 0.4026 km/sec when it left Earth. In this case the debris would have also been in an inclined orbit, and the final numbers would be almost exactly the same even if no other numbers were changed. For example, the synodic period of the Moon after the flood would be 29.501 days, instead of 29.504 days (found in Equation 37). So this assumption had no real impact on the final results.

It was also assumed the debris that impacted the Moon was launched from the Earth with a vertical velocity of 11.35 km/sec. To measure the sensitivity to this assumption, the calculations outlined here were duplicated with many other vertical launch velocities. Without changing any other numbers, as long as the velocity was between 11.26 km/sec (the minimum velocity sufficient to reach the Moon) and 11.88 km/sec, the Moon's orbit always became more eccentric, and the lunar month was also shorter than before the flood. Both of these changes are consistent with what we see today. Also, velocities in this range from 11.26 to 11.88 km/sec are consistent with the values estimated in Table 39 on page 571. So, this assumption was reasonable, and the final results were not affected significantly by slight changes in the estimated velocity.

It was also assumed that the Earth lost 3% of its mass at the time of the flood, and 1.22% of this mass impacted the Moon. The first number was based on the two different studies that estimated the mass of all the TNOs and has a confidence of roughly ± 1% (reference page 352 and Footnote 136 on page 367). The second number was selected to demonstrate that is very plausible that the Moon's orbit was altered during the flood even if only a very small percentage of debris impacted the Moon. Although 1.22% is a small number if the debris from the flood was evenly distributed in a sphere radiating from the surface of the Earth, we would only expect 0.7% of it to impact the Moon.[8] Never-the-less, 1.22% is still reason-

able considering the debris was probably not uniformly distributed and may have been more concentrated near the Earth's equator than at the poles.

Conclusions

It is very likely the Moon was in a circular orbit with a 30-day synodic period before the flood. Many ancient writings suggest there was once a 30-day lunar month, and there are physical characteristics on the Moon that indicate the asteroids or comets that hit the Moon came from the Earth. Furthermore, calculations show that if only a very small percentage of debris launched by the fountains of the great deep impacted the Moon, it could have changed the lunar orbit to what we see today. The calculated parameters of the Earth and Moon after the flood are all very close to the known values today. Table 1, compares seven of these calculated parameters with the actual values. Notice, the calculated values are only off by a fraction of a percent. On average the absolute values of percent errors listed in Table 1 are only 0.031%!

Table 1. Comparison of Calculated Parameters and Actual Parameters for the Moon Today

Parameter	Equation	Calculated Value	Actual Value	Error	Percent Error
Earth's Gravitational Parameter (km^3/sec^2)	28	398600.4	398600.4	0.0	0.00%
Moon's Gravitational Parameter (km^3/sec^2)	24	4902.8	4902.8	0.0	0.00%
Moon's Semimajor Axis (km)	31	384,514	384,400	114	0.03%
Moon's Radius of Perigee (km)	35	363,396	363,300	96	0.04%
Moon's Radius of Apogee (km)	35	405,632	405,500	132	0.03%
Moon's Eccentricity	34	0.05492	0.05490	0.00002	0.04%
Moon's Synodic Period (days)	37	29.504	29.53	-0.0260	-0.09%

Based on this analysis, it seems very plausible that prior to the flood the Moon had a circular orbit and a 30-day synodic period. If only 1.22% of the mass ejected from the Earth at the time of the flood impacted the Moon, it is very reasonable that it would have altered the Moon's orbit, resulting in the orbit we see today.

At the end of the creation week, "God saw all that He had made, and behold, it was very good." [Genesis 1:31] Although we are unable to truly appreciate how "very good" the original creation was, we now can better imagine how "very good" the preflood system was for measuring time.

References and Notes

1. "Moon Fact Sheet", NASA. http://nssdc.gsfc.nasa.gov/planetary/factsheet/moonfact.html.
2. R. A. Parker, "Ancient Egyptian astronomy," *Philosophical Transactions of the Royal Society of London. Series A, Mathematical and Physical Sciences*, Vol.276, No. 1257, 2 May 1974, p. 51.
3. Frank Parise, *The Book of Calendars* (Gorgias Press LLC,
4. Ibid., p.44.
5. Wayne Horowitz, "The 360 and 364 Day Year in Ancient Mesopotamia" *Journal of the Ancient Near Eastern Society*, Vol. 24, 1996, p. 36.
6. T. Freeth et al., "Decoding the ancient Greek astronomical calculator known as the Antikythera Mechanism," *Nature*, Vol. 444, 30 November 2006, pp. 587-591.
7. Dileep Kumar Kanjilal, "The origin of the Concept of the Intercalary Month (Malamâsa) in India," *Annals of the Bhandarkar Oriental Research Institute*, Vol. 77, No. 1/4 (1996) p. 259.
8. The surface area of a sphere at a radius equal to the distance from the Earth to the Moon is $4\pi(395{,}844)^2$. In comparison, the cross section of the Moon's sphere of influence (SOI), with a radius of 66,100 km is $4\pi(66{,}100)^2$. This is 0.7% of the surface area of a sphere with a radius from the Earth to the Moon.